

cirro-stratus to alto-stratus. Snow began at 4 a. m. of the 11th, continuing thru the entire day.

February 12, 1905, snow continued during the night of the 11th and the greater part of the 12th; at 4 p. m. the sky cleared, showing a faint halo; at 4:30 p. m. a perfect parheliion was observed. Weather on the 13th cloudless and very cold; temperature 25° below zero.

February 18, 1905, 9 a. m., solar halo, 45°, very bright, lasting until 2:30 p. m. Increasing cloudiness after 3 p. m.; complete cloudiness at 4:30 p. m. A faint lunar halo was observed at 11 p. m. Snow began soon after 7 a. m. of the 19th, continuing during the day.

March 1, 1905, 10:30 a. m., solar halo, 45°, very bright, lasting until 12:30 p. m. The 2d opened with dense fog, followed by clear and pleasant weather.

March 4, 1905, 4 p. m., solar halo, 22°, faint; fading and reappearing until 5:25 p. m. Fair and pleasant on the 5th.

March 5, 1905, solar halo, 22°, bright and well defined, lasting until 12 noon. The morning of the 6th was cloudy and threatening; rain fell in the afternoon.

March 26, 1905, 2:15 p. m., solar halo, 22°, moderately well defined, lasting until 4:30 p. m. Thunder with showers on the 27th.

April 11, 1905, 4:30 p. m., solar halo, 22°, faint. Cool and cloudless next day.

April 22, 1905, 8:30 a. m., solar halo, 45°, lasting until 4 p. m., well defined, especially brilliant from 10 a. m. until 11:30 a. m. Unsettled weather on the 23d; rain and thunder during following night and next day, the 24th.

May 14, 1905, 7:45 p. m., lunar halo, 21°, quite well defined, lasting until 9:30 p. m. Thundershowers afternoon of the 15th.

May 18, 1905, 10 a. m., solar halo, 45°, very fine and bright, lasting until 2 p. m. At 9 p. m., lunar halo, 22°. Clear, with normal temperature on the 19th.

May 24, 1905, 9 a. m., solar halo, 45°, bright and well defined. Thundershowers on the 25th.

May 29, 1905, 11 a. m., solar halo, 22°, well defined, but lasting only a short time. Light rain the same afternoon and the next day.

June 14, 1905, 2 p. m., solar halo, 45°, well defined. Generally clear and warm on the 15th.

June 16, 1905, 2 p. m., solar halo, 22°. Weather unsettled on the 17th, but no rain.

September 14, 1905, 9 a. m., solar halo, 22°, lasting until noon; very bright and well developed. Showers late in the afternoon of the same day, continuing during the night and the next day.

October 13, 1905, 2:30 p. m., solar halo, 22°, bright; lunar halo at 8:15 p. m. 22°, bright. Thunderstorms and rain on the 14th.

December 8, 1905, 10 p. m., lunar halo, 45°, very bright and well defined. (Hurricane crossing Florida.) No rain on the 9th.

December 9, 1905, 2 p. m., solar halo, 45°, well defined. (Hurricane off South Atlantic coast.) Cloudless skies, with bracing, cool temperature on the 10th.

December 12, 1905, 3 p. m., solar halo, 45°, well defined. (Storm along Texas coast.) Weather clear on the 13th.

December 17, 1905, 11 a. m., solar halo, 45°, very fine. Weather generally clear on the 18th.

December 18, 1905, 8:30 a. m., solar halo, 45°, brilliant for half an hour. (Storm in Rio Grande Valley.) Cloudy on the 19th; rain and snow on the 20th.

December 30, 1905, 10 a. m., solar halo, 22°, pale. Light snow night of the 30th.

January 5, 1906, 12:30 p. m., solar halo, 22°, pale. Weather clear on the 6th.

January 18, 1906, 1:30 p. m., solar halo, 22°, pale. Fair next day.

January 19, 1906, 10 a. m., solar halo, 45°, well defined, lasting until 3 p. m. Rain soon after 12 midnight of the 20th.

January 20, 1906, 9 a. m., solar halo, 22°, lasting two hours; at times very bright and at others pale and indistinct, alternating. Rain soon after 12 midnight, changing to snow on the 21st.

January 29, 1906, 7:15 p. m., lunar halo, 22°, bright. Fine weather on the 30th.

February 11, 1906, 1:30 p. m., solar halo, 45°, bright and well defined. Cloudy on the 12th; rain and snow on the 13th.

February 16, 1906, 2:30 p. m., solar halo, 22°, bright. Light snow during most of the forenoon next day.

April 3, 1906, 10:19 a. m., solar halo, 45°, bright and well defined. Rain began 4 p. m. of the 4th.

June 1, 1906, 7:45 a. m., solar halo, 45°, bright and well defined. Weather next day mostly clear.

June 2, 1906, 10:35 a. m., solar halo, 22°. Unsettled with showers on the 3d.

September 27, 1906, 12 m., solar halo, 45°, very bright and well defined, lasting until 3 p. m., but becoming pale and ill-defined at about 2:30 p. m. Cloudiness increased rapidly during the afternoon, and rain began at 2:30 a. m. of the 28th. (A Gulf storm of marked energy was near the mouth of the Mississippi at 7 a. m. of the 27th. The morning of the 27th was cloudless at Columbia; cirrus appeared, moving from the SSE., at about 11:35 a. m., changing rapidly to cirro-stratus. Alto-stratus appeared at about 2:30 p. m., then cumulus, strato-cumulus, and stratus, all within the following three hours.)

OBSERVATIONS OF HALOS AND CORONAS IN ENGLAND.

By M. E. T. GHEURY. Dated Eltham, England, June 6, 1907.

Casual observers of halos and coronas can not realize how frequent these phenomena really are, as shown by the great number observed when they are made the object of systematic daily and nightly observations.

While I should have stated a few months ago, as an estimate of their probable number in these latitudes, that there might be yearly perhaps ten or so, taking as a basis my recollections of my observations of the previous years, a systematic inspection of the sky, begun this year, has yielded twice that number for the first quarter of the year only. They promise an interesting study both by the variable appearance of the phenomena themselves and by the different meteorological changes accompanying them. This number, however, may be quite exceptional; it is influenced by the age of the moon, since, in exactly similar favorable meteorological conditions, the presence or the absence of the moon above the horizon from nightfall to midnight will obviously make all the difference between such a phenomenon taking place or not.

On the other hand, one can not be always observing, and it is certain that a large number of phenomena are not recorded.

The present systematic observation was undertaken to ascertain if these phenomena—since their cause is purely an atmospheric one—could not be taken as the basis of forecasts of the approaching weather, and, incidentally, to test the theories brought forward by Prof. J. M. Pernter in his *Meteorologische Optik*, whenever they were displayed with sufficient brightness to lend themselves to accurate measurements with a sextant.

Before giving the results of the observations of the first quarter of this year, some remarks which were made in the course of these observations should be stated as a preliminary explanation of some of the observed phenomena.

Faint halos.—The observation of a faint halo requires great care and circumspection. A halo of that kind requires continuous attention to be discerned, especially when the sky is not uniformly veiled, as the halo may be but partly visible, and be lost amongst the bright patches of an irregularly

clouded sky. On the other hand the arrangement of the clouds may produce a milky patchiness having the position and the curvature a halo should have and extending along an arc of quite as much as 90° , so as to give a momentary appearance similar to a partial faint halo. Steady attention, however, will show that this milkiness changes in position with regard to the sun, altering the appearance to the usual irregular patches of greater transparency in the nebulous layers.

Annuli.—The most rudimentary form of corona is a patch of light closely surrounding the disk of the sun or the moon and extending, as a rule, to a distance from the limb equal to the full diameter of the disk. It is sometimes of the shape of an ellipse, with the major axis vertical, and in one case observed the ellipse seemed the rudiment of a "pillar" similar to those I have observed above the sun or the moon, the width of which was about equal to the diameter of the sun.¹

It would be interesting to establish this connection between the central patch and the pillar; but, unfortunately, as a rule, the pillars show themselves when the sun is below the horizon or hidden by low banks of clouds, and it is then impossible to see the widening at the base where the pillar would assume the elliptic shape.

These patches are, I think, of special interest. I never saw them mentioned anywhere, yet they seem to be distinct and well-marked phenomena, as will be seen below. The edge is generally undefined, but, in some cases, when around the moon, it was so perfectly sharp as to lend itself to sextant measurements to within one minute of arc (see accompanying table, Nos. 5 and 13). This sharpness of the edge makes the denomination of "patch" quite misleading and inadequate, and I have therefore adopted the name of "annulus", with defined or undefined edge, in contradistinction with "corona", as measuring a ring detached from the disk. For the sun, this annulus is generally of a brownish red, like transparent smoke; this is the color I find also on the inner edge of halos or on the outer edge of coronas, and it is probably due to the overlapping of the colors of the red end of the spectrum. This is a further support to the claim of these annuli to rank as distinct phenomena in meteorological optics.

Measurements.—The unit chosen in estimating the dimensions of the phenomena is the diameter of the disk. It is practically the same for both the sun and the moon, approximately constant, and about $30'$, or half a degree.

Measurements with a sextant are difficult. A sextant with a very large mirror is required, and the measurement should be repeated two or three times, moving the index after each reading so as to be sure one has a fairly accurate observation, as shown by the agreement of the readings. For halos and coronas, which have an indistinct edge, half a degree has been so far the greatest accuracy possible. An annulus has however been measured to the nearest minute.

The best method—available only for the moon, and this in exceptional circumstances—of ascertaining accurately the dimensions of halos, coronas, and annuli is to note any star which occupies such a position as to enable the dimensions to be calculated from the coordinates of the moon at the time of observation and those of the star. Two stars are enough for the determination of the radius and of the width of a halo, if they are situated one on the inner side, the other on the outer side of the halo, just on the edge, but not necessarily on the same radius if we assume the width to be uniform. It will be realized that such a disposition, altho possible, must be rare, if we remember that the stars visible during moonlight are few, the more so in the veiled sky which is ordinarily an accompaniment of halos; and when they are visible they are as a rule anywhere but where they should be, to be of any use.

One star exactly on the edge (inner or outer) or exactly between the two edges would, however, give the radius (inner, outer, or mean) with great exactitude, as the edges are sharper to the naked eye than when observed in the mirror of a sextant, and therefore lend themselves to more accurate delineation.

The writer will be much obliged if anyone making an observation of this nature would send him full particulars² (name of the star, position with regard to the halo, and time of observation). The star should be, as mentioned above, exactly on one of the edges or midway between them. It is worth while, sometimes, when the halo is of a permanent nature, to wait till the motion of the moon brings the halo into exactly the proper position.

Observations.—The observations have been tabulated as follows:

Column 1. Number of the observed phenomenon.

Column 2. Date and hour.

Column 3. Nature of the phenomenon: Halo (single or double), corona, annulus or pillar. S.=sun; M.=moon. Rainbows are also recorded, but without the accompanying meteorological observations.

Columns 4 and 5. The minimum and maximum temperatures, in degrees centigrade, during the twenty-four hours preceding the phenomenon.

Column 6. Mean barometer during the twenty-four hours preceding the observation, from seven values from the curve plotted from readings taken at various times of the day. If continually rising or falling during this time, it is indicated by "rising" or "falling" from — to — (thus giving the mean rate of fall or rise during twenty-four hours). If the rate of change alters in sign, it is indicated as "variable"; while if the amplitude of variation is less than 0.05 inches it is indicated as "steady".

Columns 7, 8, and 9. Minimum and maximum temperatures and mean barometer during the twenty-four hours following the observation.

Column 10. Weather at time of observation.

Column 11. Sequence of weather during the following twenty-four hours. If worth mentioning, the weather occurring in the second period of twenty-four hours is stated within brackets.

Column 12. Detailed description of the phenomenon. When observed to last but a moment, it is recorded as "transient".

DEDUCTIONS.

Annuli.—Six observed.

Sun, 2. One followed by rain, one by stormy weather without rain.

Moon, 4. One followed by snow, two by wind and rain, one by fog.

Coronas.—Six observed.

Sun, 1. Followed by wind and rain.

Moon, 5. One followed by wind and rain, one by fog, one by wind and snow, two by relatively fine weather.

Halos (single or double).—Nine observed.

Sun, 8. Three followed by wind and rain or snow, three by fog, one by rain, one by stormy weather without rain.

Moon, 1. Followed by fog.

Pillars.—One observed on the moon, followed by wind and rain.

Minima.—Of fourteen double minima of temperature observed, in ten sets the second is higher.

Maxima.—Of fifteen double maxima of temperature observed, in eight sets the second is higher.

Mean barometer.—Of seventeen double values, eleven indicate a lowering of pressure after the phenomenon.

GENERAL REMARKS.

Altogether, on nineteen distinct displays (rejecting the three

² Address: care of the Royal Astronomical Society of London.

¹ See Bulletin de la Société Astronomique de France, 1900, p. 509 and 524; 1905, p. 264; 1907, p. 21; also No. 3 in the accompanying table.

No.	Date and time of day, 1907.	Nature of phenomenon.	Previous minimum.	Previous maximum.	Mean barometer for preceding 24 hours.	Following minimum.	Following maximum.	Mean barometer for following 24 hours.	Weather at time of observation.	Weather during following 24 hours.	Description of phenomenon and general remarks.
1	2	3	4	5	6	7	8	9	10	11	12
			° C.	° C.	Inches.	° C.	° C.	Inches.			
1	Jan. 4, 8 p. m.	Corona, M...	0.0	4.0	29.84, rising from 29.45 to 30.12.	0.2	9.0	30.10, falling from 30.12 to 30.02.	Fine, windy, frosty, passing clouds.	Warm, gray, misty..	Extending to 4 d. from limb. Reddish edge.
2	Jan. 27, 8 p. m.	Corona, M...	-4.9	4.4	30.10, falling from 30.22 to 29.94.	3.3	9.4	29.67, falling from 29.94 to 29.58.	Fine, cold, windy, passing clouds.	Fine and windy; stormy and rain.	Extending from 6 d. to limb. Edge strongly red.
3	Jan. 29, 6 p. m.	Pillar, M....	2.7	5.8	29.89, variable.....	0.9	4.9	29.43, rising from 29.28 to 29.70.	Fine, cold, windy, passing clouds.	Gale, with a squall of snow.	Same width as the disk, height 5 to 6 d. Moon just hidden by crest of low, black clouds.
4	Jan. 29, 10 p. m.	Corona, M.	2.7	5.8	29.36, variable.....	0.9	4.9	29.59, rising from 29.28 to 29.75.	Fine, cold, windy, passing clouds.	Gale, with a squall of snow.	Up to 6 d. from limb. Outer third reddish.
5	Feb. 2, 12 p. m.	Annulus, M.	-0.8	3.0	30.10, rising from 30.02 to 30.20.	-1.4	2.3	30.23, variable.....	Fine, still, frosty, very pure sky.	Overcast, misty, a few flakes of snow (powdered snow).	One ring colorless, with sharp red edge, width 1 d. One moment a second round it, same width, much paler; then a third, very faint, same width, round the two others.
6	Feb. 10, 2 p. m.	Halo, S.....	-0.1	7.5	29.56, variable.....	2.1	5.3	29.45, variable.....	Fine, warm, light wind, passing clouds.	Pouring rain, stormy snow (wet all day).	Halo of 22°. Sextant measure: 22° 30' from center of disk to middle of band. Inner edge red; lasted 2 hours.
7	Feb. 14, 3 p. m.	Halo and annulus, S.	1.3	6.0	29.60, rising from 29.40 to 29.95.	3.9	9.5	29.88, falling from 29.95 to 29.78.	Fine, warm, light wind, veiled sky.	Gray and still; rain.	Halo of 22°, indistinct, upper half only visible, inner edge slightly red. Sun in reddish ("smoky") patch. Transient.
8	Feb. 16, 2 p. m.	Halo and annulus, S.	*	*	29.78, variable.....	4.8	10.7	29.85, variable.....	Fine, warm, windy, veiled sky.	Overcast, stormy.	Very indistinct halo of 22° upper half only visible. Sun in reddish ("smoky") patch.
9	Feb. 16, 8 p. m.	Annulus, M.	*	*	29.80, variable.....	4.8	10.7	29.85, variable.....	Fine, warm, still, overcast.	Overcast, stormy, a little rain.	Radius about 1 d. Center at center of crescent moon, undefined edge.
10	Feb. 19, noon.	Halo, S.....	4.3	9.5	29.64, variable.....	0.7	10.0	29.05, falling from 29.56 to 28.86.	Cloudy, very windy.	Stormy, pouring rain, gale, squalls of wind and rain.	Halo of 22°, inner edge reddish, outer edge bluish.
11	Feb. 25, 11 p. m.	Corona, M...	3.6	9.3	30.03, rising from 29.93 to 30.13.	5.2	6.7	30.14, rising from 30.13 to 30.19.	Overcast, gray, light wind.	Overcast, yellow fog.	Up to 6 d. indistinct, outer edge reddish.
12	Feb. 28, 8 p. m.	Double halo, S.	0.4	9.4	30.29, variable.....	0.9	11.5	30.23, falling from 30.30 to 30.15.	Fine, still, warm....	Thick white fog; fine, still, warm.	Inner halo faint, outer very faint. Sun's altitude 10°.
13	Feb. 28, 9 p. m.	Halo and annulus, M.	0.4	9.4	30.29, variable.....	0.9	11.5	30.21, falling from 30.26 to 30.15.	Fine, still.....	Thick white fog; still, warm.	Well defined halo of 22°. Sextant measurement, 22° 30'; width about 2 d. Inner edge distinctly red; lasted two hours. Annulus with sharp edge; width, by sextant, 6' from limb; round this a second faint annulus up to 1 d. from limb. Part of halo of 22°.
14	Mar. 1, 2 p. m.	Halo, S.....	0.9	11.5	30.27, falling from 30.31 to 30.21.	2.3	8.8	30.14, falling from 30.20 to 30.08.	Fine, sunny, warm, still.	Overcast, yellow fog; still and warm.	Up to 6 d.; width about 1 d.; outer edge red. No halo.
15	Mar. 12, 1 p. m.	Corona, S...	-3.1	4.4	30.28, variable.....	4.5	6.5	29.93, falling from 30.15 to 29.78.	Fine, sunny, still...	Overcast, rain, strong wind.	Halo of 22°, whitish; corona gone.
16	Mar. 12, 3 p. m.	Halo, S.....	-3.1	6.5	30.19, variable.....	4.5	9.3	29.90, falling from 30.11 to 29.75.	Fine, sunny, still...	Overcast, rain, strong wind.	With undefined edge; width about 1 d.
17	Mar. 19, 10 p. m.	Annulus, M.	†	12.1	29.63, variable.....	†	11.9	29.95, rising from 29.77 to 30.22.	Fine, sunny, fresh gale.	Fine, sunny, strong wind, rain.	Inner edge to 4 d., outer edge 5½ d.; reddish, transient.
18	Mar. 21, 10 p. m.	Corona, M...	1.2	13.3	30.21, variable.....	3.3	13.3	30.13, variable.....	Fine, still.....	Fine, light wind, overcast.	Halo of 22°, inner edge reddish.
19	Mar. 25, 9 a. m.	Halo, S.....	2.3	12.7	30.14, steady.....	3.5	13.6	30.15, variable.....	Fine, sunny, still..	Yellow fog, fine, still.	

* Gradual cooling since the maximum, 9.5°, of the 15th.

† Index displaced by vibrations.

d. = diameter.

annuli, Nos. 7, 8, and 13, as occurring simultaneously with halos), we have—

Followed by thick fog, 5.

Followed by strong wind without rain or snow, 1.

Followed by rain alone, 1.

Followed by snow alone, 1.

Followed by strong wind, with rain, or snow, or both, 9.

Followed by relatively fine weather, 2.

The four kinds of phenomena, annuli, coronas, halos, and pillars, seem, all of them, to indicate approaching disturbances, seventeen out of nineteen being followed by strong wind or rain, or snow, or fog, or several of these combined. The two failures are both coronas of the moon.

THE RELATION OF THE MOVEMENTS OF THE HIGH CLOUDS TO CYCLONES IN THE WEST INDIES.

By JOHN T. QUIN. Dated St. Croix, Danish West Indies, March 9, 1907.

In June, 1898, the Weather Bureau published at Washington, in pamphlet form, a valuable paper on West Indian hurricanes, which had been prepared by the late Father Viñes, of Havana, for presentation at the Meteorological Congress at Chicago in August, 1893.

In this very instructive paper Father Viñes lays down the theory that, while the lowest air currents in a cyclone tend inward toward the center, the higher currents become more and more divergent as we ascend, until at the level of the cirrus clouds they move in "a completely divergent radial direction". On the last-named point he is very explicit; he says, for example: "If the vortex lies to the south-southeast, the cirrus

clouds will move from the south-southeast". Again, on page 18 of the pamphlet, he speaks of a hurricane in September, 1875, the vortex of which, on the afternoon of the 12th, was over the western part of Haiti, 550 miles east-southeast of Havana, and he says that it was from this direction that the cirrus clouds were coming. Hence, there is no possibility of mistaking his meaning; the cirrus clouds, he means, come straight away from the vortex of the cyclone, even tho that vortex be at so great a distance as 550 miles.

But when we give careful attention to this statement we are confronted with the well-known law that the air currents in the Northern Hemisphere, while moving forward, tend to curve to the right on account of the earth's rotation. The volume of air which is supposed to rise from the center of the storm ought, therefore, to flow outward, not in straight lines, but in curved lines, the direction of which, at any given point of observation, would thus come to indicate, not the position of the vortex from which the stream of air had come, but that of a point to the right of the vortex. This point, it is true, might not be far to the right at a comparatively short distance; but as the distance of the vortex from the observer increased, the divergence would increase likewise, till at last the cirrus clouds might come to be moving from a point very far away from the direction in which the storm center lay. Does this law, then, show itself in the movements of the high clouds from a cyclone center, or is it counteracted, or are its effects greatly modified, by the surrounding conditions, so that Father Viñes's statement still remains correct?

We believe that in the case of the trade wind, with which we